Vulnerability of the United States' Oil Supply to Terrorist Attack

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Preface

The purpose of this paper is to examine the vulnerability of the U.S. oil supply infrastructure (both domestic and international) to terrorist sabotage, and to offer a few solutions that might mitigate the threat. I chose this topic due to the extreme importance that oil plays in today's global economy. With oil prices at record highs (over $50 a barrel as of this writing), and with the United States consuming about 25 percent of the world's daily requirement, any interruptions to the global supply will have critical consequences for the U.S. and world economies.

The research into this topic has reinforced for me how dependent on others the United States really is with regards to our domestic energy supply. It seems obvious, at least from a national security standpoint, that the U.S. needs to place far more emphasis on developing alternative energy sources. Until then, it remains vulnerable both at home and abroad.

I would like to thank Dr. Norman Cigar and Mr. Gayland Lyles for their patient support in this endeavor. Their knowledge, guidance, and encouragement greatly assisted my efforts.

Executive Summary

Title: Vulnerability of the U.S. Oil Supply to Terrorist Attack

Author: Major J.J. Stower, United States Marine Corps

Thesis: The United States' oil supply infrastructure is very vulnerable to terrorist attack both at home and abroad.

Discussion: This paper examines the vulnerability of the U.S. oil supply infrastructure (domestic and international) to terrorist sabotage, and the economic implications of such an attack. It will show that many vulnerabilities exist within the supply system, examines the effects of attacks on those vulnerabilities, and offers various solutions that could mitigate the threat of sabotage and its consequences. The U.S. possesses only 3% of the world's total reserves, yet uses approximately 25% of the world's oil. Because of this, the U.S. is dependent on external sources of supply. It imports about 50% of its total requirement, and 20% of these imports are from the Middle East and North African (MENA) region. After the terrorist attacks of 11 September 2001, protection of the U.S. energy infrastructure became a key domestic issue for Washington, D.C. policy makers. Although many security measures were in place prior to 9-11, the emphasis was on safety, countering vandals, and stopping minor sabotage from the odd enviro-activist group. Domestically, the focus was not on terrorism. Feeding off the instability and volatility existing in the MENA region and elsewhere, terrorists threaten the infrastructure of the oil industry, internationally as well as domestically. Because of oil's volatile nature as a substance, its restricted flow through critical chokepoints, and its strategic importance to the global economy, the world's oil infrastructure offers lucrative targets for terrorists.

Conclusion: The United States cannot insulate itself from the global oil market. To do so would mean becoming totally independent of any globally traded sources of energy. The U.S. oil industry and the U.S. government are currently taking all the reasonable steps to make the U.S. domestic infrastructure secure. The chief vulnerability, however, resides in the country's foreign sources of supply and the international oil transportation infrastructure. The mitigation of this vulnerability can be accomplished through several avenues. One way is to encourage and assist other oil-producing nations to effectively secure all aspects of their infrastructure. Another way falls into the diplomatic realm, with the U.S. promoting worldwide security and stability. A third option is to hunt down and kill the threat.

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Part I: OVERVIEW

Introduction

This paper examines the vulnerability of the U.S. oil supply infrastructure (domestic and international) to terrorist sabotage, and the economic implications of such an attack. It will show that many vulnerabilities exist within the supply system, examines the effects of attacks on those vulnerabilities, and offers various solutions that could mitigate the threat of sabotage and its consequences.

The oil industry is a highly globalized one, and any study of the U.S. oil supply must include coverage of both the domestic infrastructure as well as that of foreign suppliers. The U.S. possesses only 3% of the world's total reserves, yet uses approximately 25% of the world's oil. Because of this, the U.S. is dependent on external sources of supply. It imports about 50% of its total requirement, and 20% of these imports are from the Middle East and North African (MENA) region.[1]

[1] Richard Gibson, "Some Interesting Oil Industry Statistics," URL: <www.gravmag.com/oil.html#imports>, accessed 5 April 2005.

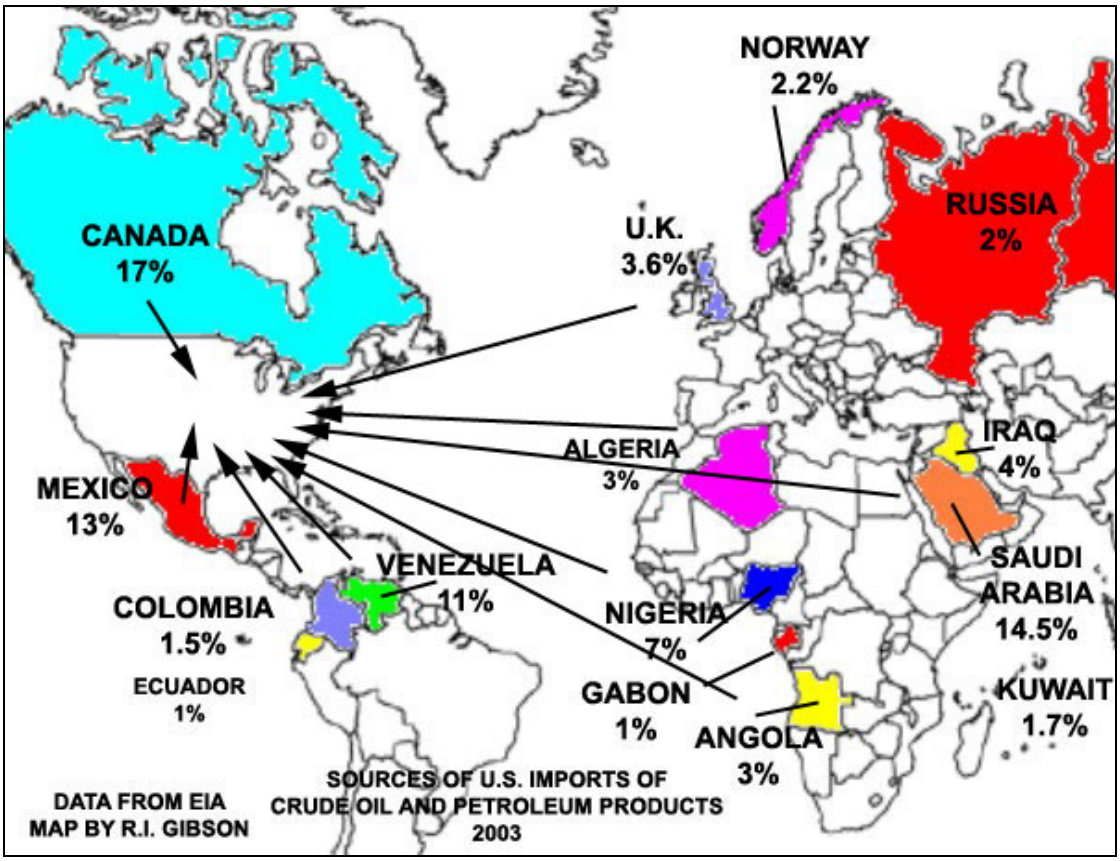

Figure 1: Sources of U.S. Oil[2]

After the oil shock of the early 1970's, America's "Project Independence" was conceived. It was a plan to develop methods to reduce America's dependence on foreign oil sources, specifically from those in OPEC (Organization of Petroleum Exporting Countries). It promised various solutions that included the hopeful discovery of non-MENA oil reserves, production of oil from shale, conservation, nuclear power, as well as other alternative energy sources (geo-thermal, wind, solar, etc.). None of these, however, has succeeded in altering

[2] Richard Gibson, "Some Interesting Oil Industry Statistics," URL: <www.gravmag.com/oil.html#imports>, accessed 5 April 2005.

the U.S. dependence on the MENA oil supply (See Figure 1 and Table 1).

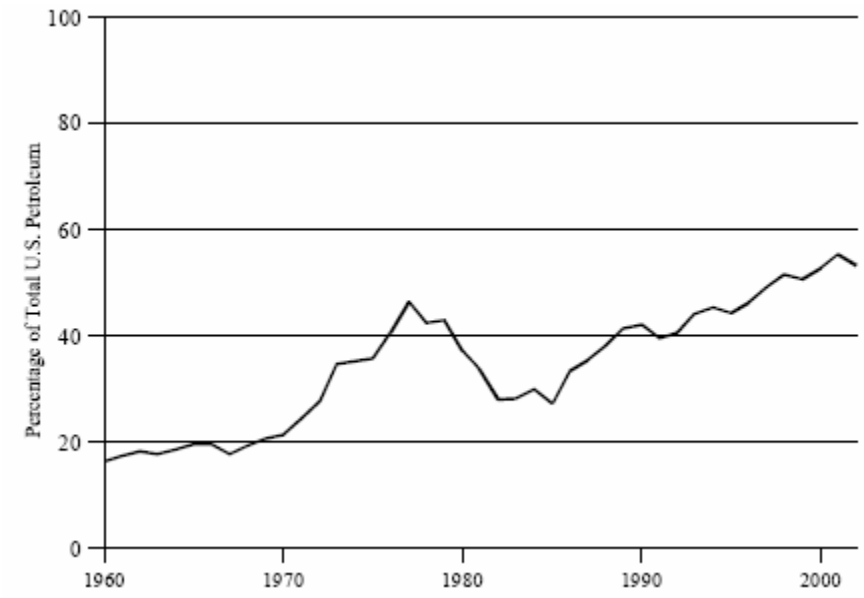

Table 1: U.S. Dependence on Imported Petroleum (1960-2002)[3]

Oil remains the most efficient, flexible way to transport energy over long distances.[4] In the mid-1970's, the U.S. Strategic petroleum reserve was created to help buffer any future shocks from disturbances in the imported supply, but America's ever-expanding economy is quickly negating the value of that reserve. In 1985, it stored enough oil to augment

[3] Carol Glover, "Energy: Useful Facts & Numbers," *CRS Report for Congress*, RL31849 (Washington, DC: Congressional Research Service, Library of Congress, 18 March 2004), 8.
[4] Anthony H. Cordesman, "Middle Eastern Energy after the Iraq War: Current and Projected Trends," *Middle East Policy*, 10, no. 4 (2003): 126.

domestic supply for 300 days. Today, there is only enough oil stored to replace imports for 53 days.[5]

After the terrorist attacks of 11 September 2001 (9-11), protection of the U.S. energy infrastructure became a key domestic issue for Washington, D.C. policy makers.[6] Although many security measures were in place prior to 9-11, the emphasis was on safety, countering vandals, and stopping minor sabotage from the odd enviro-activist group. Domestically, the focus was not on terrorism.[7]

Feeding off the instability and volatility existing in the MENA region and elsewhere, terrorists threaten the infrastructure of the oil industry, internationally as well as domestically. Because of oil's volatile nature as a substance, its restricted flow through critical chokepoints, and its strategic importance to the global economy, the world's oil infrastructure offers lucrative targets for terrorists. Indeed, on 15 December 2004, an Osama Bin Laden audio recording was released in which he called for Persian Gulf militants to "attack oil facilities all over the region" to prevent the West

[5] "Strategic Petroleum Reserve: Quick Facts and Frequently Asked Questions," *U.S. Department of Energy Office of Fossil Energy* website, <http://www.fe.doe.gov/programs/reserves/spr/spr-facts.html>, accessed 5 April 2005.
[6] Maureen Lorenzetti, "U.S. Energy Infrastructure now a Key Issue in Washington," *Oil & Gas Journal*, 1 October 2001, 22.
[7] Paula Dittrick, "U.S. Oil, Gas Companies Reassessing Post-Sept 11 Security Risks," Oil & Gas Journal, 22 April 2002, 24.

from getting Arab oil.[8] This paper discusses the vulnerability of the many nodes along the U.S. oil supply infrastructure.

Global Commodity

Anthony Cordesman, in an essay for the journal *Middle East Policy*, eloquently describes the global importance of the world's oil supply:

> Oil is a global commodity distributed in a global market. With the exception of differences in price because of crude type and transportation costs, all buyers compete equally for the supply of available exports, and the direction and flow of exports changes according to demand. The percentage of oil that flows from the Middle East to the United States at any given time has little strategic or economic importance. If a crisis occurs, or prices change drastically, the source of U.S. imports will change accordingly.[9]

Here, Cordesman illustrates that the oil market is truly global, with one global market price. Regardless of where a county's oil is imported from, the price will be the same (more or less, factoring in transit mileage). The only way a country can escape paying the global market price is to nationalize its own supply. He goes on to explain that it is very difficult for the United States to isolate itself from this global oil market, even if it manages to somehow develop a viable alternate supply for itself:

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[8] Mordechai Abir, "The Al-Qaeda Threat to Saudi Arabia's Oil Sector," brief for the *Jerusalem Center for Public Affairs*, vol. 4, no. 13, 28 December 2004, <http://jcpa.org/brief/brief004-13.htm>, accessed 5 April 2005.
[9] Anthony H. Cordesman, "Middle Eastern Energy after the Iraq War: Current and Projected Trends," *Middle East Policy*, 10, no. 4 (2003): 126.

> The United States is also increasingly dependent on the health of the global economy. U.S. economic activity and growth is dependent on how well the economies of Europe, Asia and Latin America function. With the exception of Latin America, Mexico and Canada, all of America's major trading partners are critically dependent on Middle Eastern oil exports.[10]

The Threat

There has been a history of attacks on the oil infrastructure, both foreign and domestic. Though not all attributable to terrorism (some were unconventional military operations, others by environmental activists), these attacks highlight the vulnerability of a vast and complex energy system, both in the physical and cyber realm. The primary threat today is sabotage by radical Islamic terrorist groups such as Al Qaida. 9-11 has demonstrated their global reach, and attacks on Iraqi and Saudi oil nodes have demonstrated their intent. The oil pipelines and facilities in Iraq have become a popular target for insurgents, and with the December 2004 audio release, "al-Qaeda's leadership has openly divulged its strategy of hitting the Western economy by disrupting oil supplies and causing prices to skyrocket."[11]

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[10] Anthony H. Cordesman, "Middle Eastern Energy after the Iraq War: Current and Projected Trends," *Middle East Policy*, 10, no. 4 (2003): 126.
[11] Mordechai Abir, "The Al-Qaeda Threat to Saudi Arabia's Oil Sector," brief for the *Jerusalem Center for Public Affairs*, vol. 4, no. 13, 28 December 2004, <http://jcpa.org/brief/brief004-13.htm>, accessed 5 April 2005.

In Saudi Arabia, terrorists have attacked the oil industry over the last two years both directly and indirectly. Al Qaida has also attacked the compounds housing foreign oil workers, in an attempt to have a "future impact on the foreign expertise Saudi Arabia still needs for some aspects of its energy production."[12] "They are trying to target the oil industry and scare people - and in particular foreigners - into leaving the country", Saudi government adviser Adel al-Jubeir told the BBC. "They believe that if this happens, the Saudi economy will collapse and the Saudi government will be ripe for the plucking" due to the loss of critical corporate knowledge and experience.[13]

Domestically, "activist" groups (domestic terrorists?) have made several attacks on the Trans-Alaskan Pipeline, most prevalent after it was first completed in the 1970's. The FBI also reports that they are looking for Al Qaeda figures who may have been targeting oil and chemical plants in Texas and Los Angeles to attack over the 4th of July holiday in 2003. The suspects are believed to have ties with Chad and Sudan.[14] It is reported that U.S. intelligence estimates "perhaps thousands of

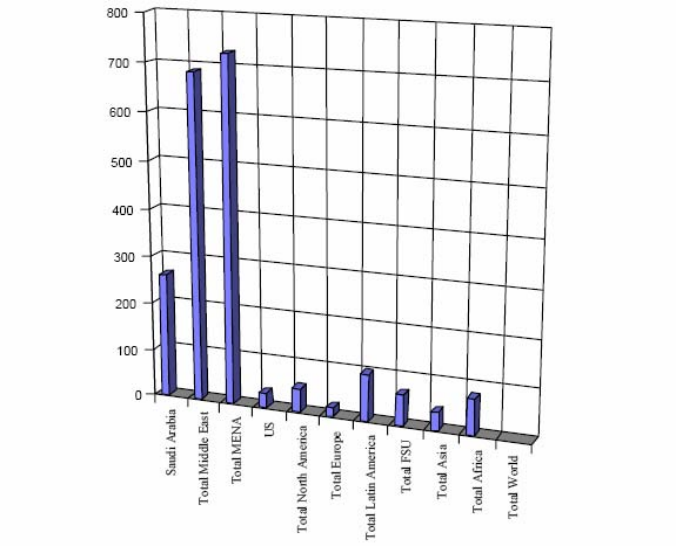
[12] Anthony H. Cordesman, "Energy Developments in the Middle East" draft report for the Center for Strategic and International Studies, Washington, D.C., 15 March 2004, 100.
[13] Richard A. Greene, "Is the Saudi Oil Industry Safe?," *BBC News Online*, 3 June 2004, <http://news.bbc.co.uk/1/hi/world/middle_east/3771097.stm>, accessed 5 April 2005.
[14] "New al Qaeda focus: Sudan, Chad," *U.S. News & World Report*, 3 July 2003, 1.

highly motivated and well-trained terrorists may be living among us, blending in and awaiting a time to strike."[15]

[15] Judy Clark, "Terrorist mindset," *Oil & Gas Journal*, 22 April 2002, 19.

Part II:CURRENT SOURCES

In order to properly examine the vulnerability of the United States' oil supply, it is necessary to identify its major sources of supply, both domestic and foreign.



	Saudi Arabia	Total Middle East	Total MENA	US	Total North America	Total Europe	Total Latin America	Total FSU	Total Asia	Total Africa	Total World
Billions of Barrels	261.6	685.6	725.5	30.4	49.9	19.1	98.6	65.3	38.7	77.4	1047..7
% of World	*25.0	*65.4	*69.3	*2.9	*4.8	*1.9%	*9.4	*6.4	*3.7	*7.4	*100

Table 2: World Oil Reserves, 2003 Estimate[16]

U.S. Domestic Sources

Domestically, according to the National Academy of Sciences, the U.S. has approximately 878,000 oil wells, 161 oil refineries, and 220,000 miles of oil pipeline.[17] The domestic

[16] Anthony H. Cordesman, "Energy Developments in the Middle East" draft report for the Center for Strategic and International Studies, Washington, D.C., 15 March 2004, 17.
[17] Kathleen McFall, "Post-9/11 Investigations Reveal Oil, Gas Achilles Heel Multiple vulnerabilities are in sprawling U.S. energy chain," *Engineering News Record*, 10 March 2003, 11.

oil infrastructure is highly decentralized in its transmission and distribution operations. This decentralization makes it hard to conduct a concentrated, decisive attack, but also makes it difficult to adequately secure it against a terrorist threat. Refinery operations, however, seem to be more concentrated geographically than the other portions of oil infrastructure, with approximately 40% of the refineries located in either Texas or Louisiana.[18] Conversely, this concentration may simplify the targeting process for a terrorist, but also allow for more focused security efforts.

Middle East & North Africa Sources

The United States imports approximately 25% of its international supply from Middle Eastern and North African (MENA) sources. This, seemingly the world's most volatile region, contains an estimated 66% of the world's total oil reserves. Unfortunately, as exemplified by events over the last forty years, "…the world's leading oil producing countries and holders of the lion's share of global reserves are either politically unstable and/or, in the words of President George W.

[18] Kathleen McFall, "Post-9/11 Investigations Reveal Oil, Gas Achilles Heel Multiple vulnerabilities are in sprawling U.S. energy chain," *Engineering News Record*, 10 March 2003, 11.

Bush, 'don't particularly like the U.S.'."[19] Six countries in this region control the majority of the MENA region oil: Saudi Arabia, United Arab Emirates, Kuwait, Iran, Iraq, and Algeria.

Saudi Arabia, the third-biggest supplier of U.S. oil (after Mexico and Canada), contains by far the largest reserves, estimated to be at about 25% of the world's total. Perhaps of even more importance, though, is that it has the only significant excess production capacity for the world, about 2.5 mbd, making it the only "guarantor of liquidity" in the world oil market. [20] These impressive statistics serve to ensure Saudi Arabia's role as a major player in the world's energy markets.

In comparison to the United States, the Saudi oil infrastructure is relatively concentrated within it various components. Only Eight oil fields contain most of Saudi reserves. The world's largest onshore oil field, Ghawar, accounts for half of that country's total oil production capacity. Saudi Arabia also boasts the world's largest offshore oil field—Safaniya. The Abqaiq facility, located twenty-five miles inland from the Gulf of Bahrain, processes over two-thirds of the oil extracted. To export this massive amount of oil, there are only two primary terminals on the Persian Gulf coast:

[19] Anne Korin and Gal Luft, "Terror's Next Target?," *Journal of International Security Affairs*, Winter 2004, 96.
[20] Anne Korin and Gal Luft, "Terror's Next Target?," *Journal of International Security Affairs*, Winter 2004, 96.

Ras Tanura and Ras al-Ju'aymah. Ras Tanura, as the world's largest facility of its kind, processes one-tenth of the world's oil supply daily. Two other major terminals, Yanbu and Rabigh, are located on the Red Sea, connected to Abqaiq by a 750-mile pipeline.[21]

Figure 2: Overview of Saudi Arabian Pipelines and Terminals[22]

The country of Nigeria, the U.S.'s fifth largest supplier of oil, contains Africa's largest oil reserves. An important point to note about Nigeria is that about half of Nigeria is controlled under *sharia*, or Islamic Law. Intelligence sources have found that al Qaeda has made several attempts to unite

[21] Anne Korin and Gal Luft, "Terror's Next Target?," *Journal of International Security Affairs*, Winter 2004, 95.
[22] Richard A. Greene, "Is the Saudi Oil Industry Safe?," *BBC News Online*, 3 June 2004, <http://news.bbc.co.uk/1/hi/world/middle_east/3771097.stm>, accessed 5 April 2005.

various sympathetic Islamic groups within Nigeria against the West. [23]

Other Major Sources

In the Western Hemisphere, the three major sources supplying oil to the United States are Canada, Venezuela, and Mexico. Canada has been the largest source of oil for the U.S. since 2001, supplying an average of seventeen percent of total imports. Mexico, though not as politically stable or physically secure, supplies approximately thirteen percent. Venezuela is responsible for about eleven percent, though this has fluctuated in the past two years due to political issues in what is proving to be a volatile country.[24] A workers' strike in late 2002 / early 2003 cut Venezuelan exports, constricting the flow and pushing the global price of oil up. This was the first time the U.S. supply outside of MENA was significantly disrupted, and when combined with the effect of Operation Iraqi Freedom in the Persian Gulf, "it highlighted the challenges Washington faces in responding to new threats to its oil supply."[25]

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[23] Anne Korin and Gal Luft, "Terror's Next Target?," *Journal of International Security Affairs*, Winter 2004, 97.
[24] Richard Gibson, "Some Interesting Oil Industry Statistics," URL: <www.gravmag.com/oil.html#imports>, accessed 5 April 2005.
[25] Michelle Billig, "The Venezuelan Oil Crisis," *Foreign Affairs* 83, no. 5 (2004), 2.

Part III: VULNERABILITY OF OIL SOURCES

The sprawling, global expanse of the oil supply chain reveals both strengths and vulnerabilities. Because it is so large and decentralized, an attack at any one point in the system will probably not have an apocalyptic impact on the global supply as a whole. But it is nearly impossible to secure all of the vital, varied components within the infrastructure. The vulnerabilities of the U.S. oil supply can be classified as both physical and cyber in nature. An important and overarching part of the entire oil industry is the dependence on computer technology to centralize and coordinate the operations of all of the disparate parts, so that the threat of cyber-terror will also be covered in this paper. Also, because of its global nature, the U.S. oil supply has many political vulnerabilities, given the volatile nature of the MENA region.

Physical Vulnerabilities

The oil supply infrastructure is incredibly capital-intensive. A single well may cost $50 million, while an offshore well might cost 10 times as much. Mankind’s largest vehicles, oil tankers, cost many millions of dollars. Pipelines may cost up to $1 million per mile, and require $40 million pumping stations every 40 or so miles. Each refinery, storage,

and distribution terminal costs multiple millions of dollars.[26] The physical vulnerabilities among these various system components varies.

The global oil supply infrastructure is very decentralized. This is good in that it would be difficult for any terrorist group to do significant damage with a single attack. On the flip-side, however, this decentralization makes it difficult to provide a high amount of physical security along the entire system. The risks from attack vary among the several components within the infrastructure of the oil industry. The major components can be classified as production (oil wells), gathering (pipelines), processing (refineries), transmission (pipelines), storage (oil terminals, U.S. Strategic Oil Reserve), and distribution (pipelines, trucks, ships, railroads, gas stations). The possible impact of an attack on these components varies from low (local impact, short duration) to high (major disruption with regional or national impact).

[26] David J. Lesar, "Securing Oil and Natural Gas Infrastructures in the New Economy," report to the National Petroleum Council, June 2001, 32.

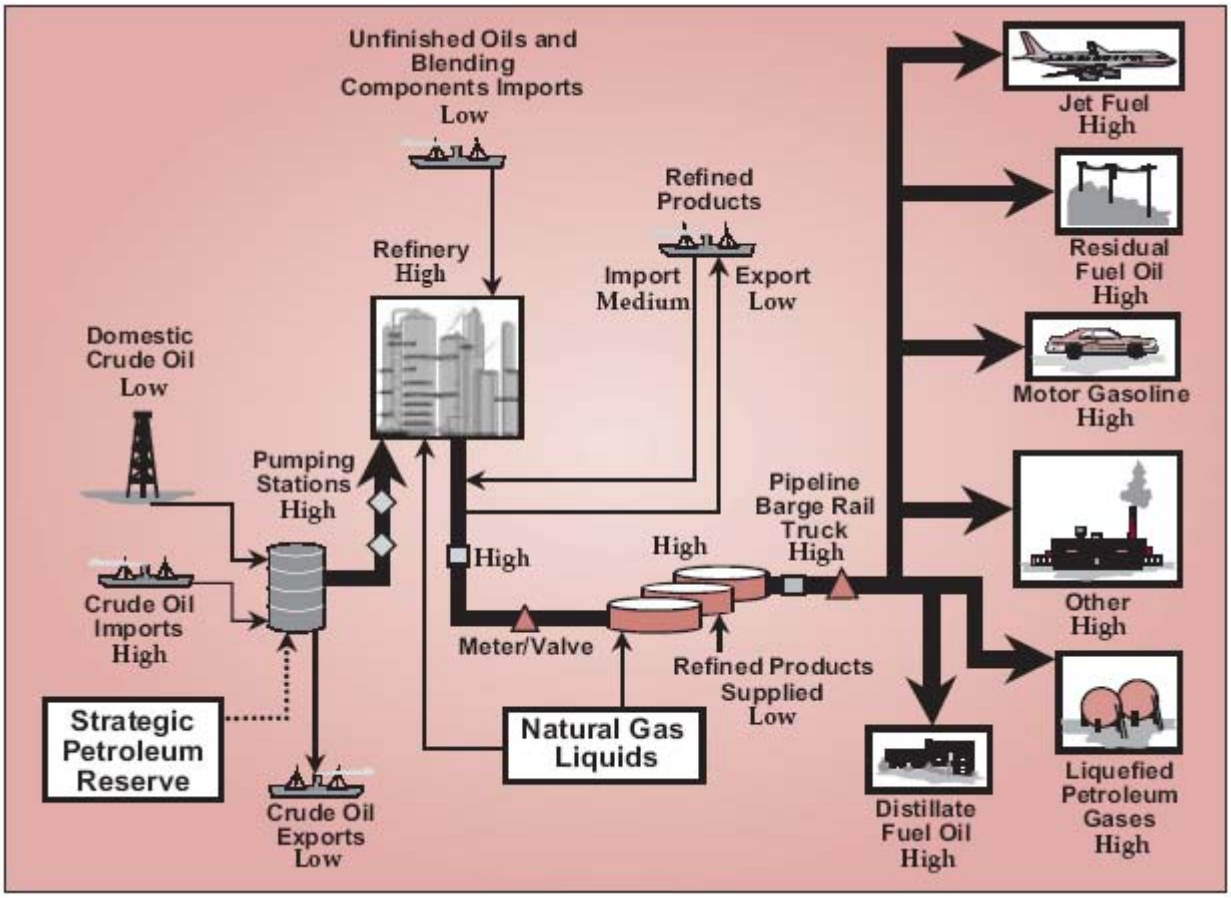

Figure 3: General Vulnerability Rankings of the Global Oil Infrastructure[27]

Fixed, manned, and relatively high-dollar facilities such as distribution centers, refineries, and storage facilities are generally "hardened" against kinetic threats using the traditional methods of "guns, gates, and guards," especially in this post-9-11 world. The majority of the physical challenge lies with the "soft" nature of the transmission and distribution components of the supply architecture.

[27] David J. Lesar, "Securing Oil and Natural Gas Infrastructures in the New Economy," report to the National Petroleum Council, June 2001, 33.

Pipelines are the method of choice for trans-continental oil transportation. Relatively speaking, they are cheaper than shipment by truck, ship, or rail, and are also relatively low maintenance and their operation is highly automated. Spanning thousands of miles, with multiple pumping stations interspersed, the pipeline system defies the traditional security measures found at individual facilities. Whether under or above the ground, pipelines offer an easy target to saboteurs.[28] Easily damaged by an explosive charge, a pipeline can discharge thousands of gallons of oil into the environment before its automatic detection system stems the flow. Add fire to this, and a fine media event is created. Moreover, with the remote nature of some pipelines, the difficulties of repair become obvious. The Trans-Alaskan pipeline for example, located above ground due to the perma-frost, cannot be repaired for long periods during the Alaskan winter. Even pipelines located below ground are not difficult targets for terrorists to locate, given the necessary pipeline markers for safety and the fact that they generally lie within established “energy corridors” along with electricity and natural gas lines.

[28] David J. Lesar, “Securing Oil and Natural Gas Infrastructures in the New Economy,” report to the National Petroleum Council, June 2001, 34.

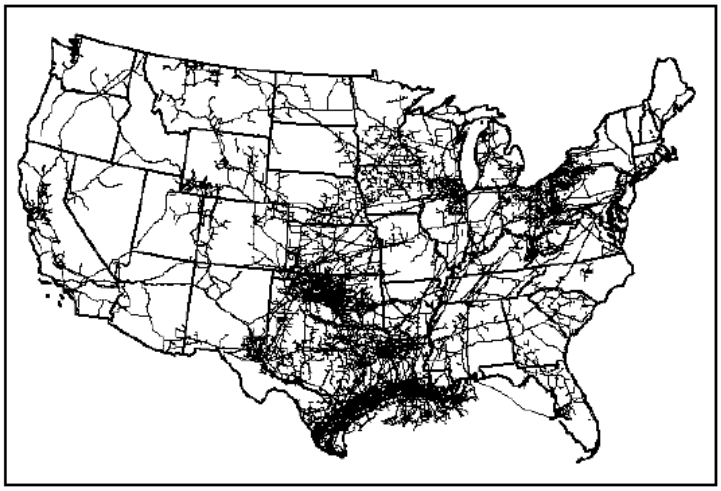

Figure 4: Major Pipelines within the Continental United States[29]

Oil transport by ship has two primary vulnerabilities. First, an unescorted oil tanker is big and slow. There are over 4,000 oil tankers in the world, so that it is impossible to offer each one an escort vessel.[30] They are particularly vulnerable to attack from an explosive-filled powerboat, as Al Qaeda demonstrated on the French supertanker *Limberg* off the coast of Yemen on 6 October 2002.[31]

Secondly, and more importantly, the geography of the MENA region channels much of the world's oil supply through one of three narrow sea straits: the entrances to the Persian Gulf (Strait of Hormuz) and the Red Sea (Bab el-Mandeb), and the

[29] Paul W. Parfomak, "Pipeline Security: An Overview of Federal Activities and Current Policy Issues," *CRS Report for Congress,* RL31990 (Washington, DC: Congressional Research Service, Library of Congress, 5 Feb 2004), 2.
[30] "Threats to Oil Transport," *Institute for the Analysis of Global Security* web site, <www.iags.org/oiltransport.html>, accessed 5 April 2005.
[31] "Threats to Oil Transport," *Institute for the Analysis of Global Security* web site, <www.iags.org/oiltransport.html>, accessed 5 April 2005.

Straits of Malacca between Malaysia and Indonesia. These routes have two major disadvantages. First, they are very narrow, and a single burning oil tanker with its accompanying burning oil slick could effectively block the route for days or weeks. Secondly, these straits are "controlled by Muslim countries where terrorists are known to operate."[32] The attack on the Limburg in 2002 prompted the U.S. Navy's Maritime Liaison Office in Bahrain to warn that "shipmasters should exercise extreme caution when transiting…strategic chokepoints such as the Strait of Hormuz, or Bab el-Mandeb, or…[other] traditional high-threat areas such as along the Horn of Africa."[33]

Bab el-Mandeb is the strait which connects the Red Sea with the Gulf of Aden and the Arabian Sea. Closure of this strait would prevent Persian Gulf tankers from reaching the Suez Canal / Sumed Pipeline complex, causing them to divert around the Cape of Good Hope on the southern tip of Africa. Oil prices would increase substantially because of the increased transit costs. In addition, all non-oil shipping would be blocked from using

[32] "Threats to Oil Transport," *Institute for the Analysis of Global Security* web site, <www.iags.org/oiltransport.html>, accessed 5 April 2005.
[33] "World Oil Transit Chokepoints," *Energy Information Agency, U.S. Department of Energy* web site, <www.eia.doe.gov/emeu/security/choke.html>.

the Suez Canal, impacting not only Egyptian revenues, but the supply and prices or other major world commodities.[34]

Figure 5: Bab el-Mendab Strait[35]

The Strait of Hormuz connects the Persian Gulf with the gulf of Oman and the Arabian Sea. Considered the "world's most important oil chokepoint", this narrow strait sees thirteen million barrels of oil a day pass through it. With its shipping channel measuring only two miles wide, it is an easy target area for anyone looking for a congested zone of large, slow vessels.[36]

[34] "World Oil Transit Chokepoints," *Energy Information Agency, U.S. Department of Energy* web site, <www.eia.doe.gov/emeu/security/choke.html>.
[35] "Bab el-Mendab," Encarta Online Atlas, <http://encarta.msn.com/map>, accessed 5 April 2005.
[36] "World Oil Transit Chokepoints," *Energy Information Agency, U.S. Department of Energy* web site, <www.eia.doe.gov/emeu/security/choke.html>.

Figure 6: Strait of Hormuz[37]

The Strait of Malacca connects the Indian Ocean with the Pacific Ocean and the South China Sea. The shipping which passes through here affects the economies of South and East Asia. It is considered a key chokepoint for the region because it is the shortest route between India, China, and Indonesia—three of the world's most populous countries. Its narrowest point is only 1.5 miles wide (the shipping lane in the Phillips Channel), making it another inviting target for maritime terrorism.[38]

[37] "Strait of Hormuz," Encarta Online Atlas, <http://encarta.msn.com/map>, accessed 5 April 2005.
[38] "World Oil Transit Chokepoints," *Energy Information Agency, U.S. Department of Energy* web site, <www.eia.doe.gov/emeu/security/choke.html>.

Figure 7: Strait of Malacca[39]

The world's major shipping canals, the Suez and Panama Canals, are also obvious chokepoints for the maritime transport of oil. Closure of either would divert traffic around the southern tips of Africa and South America, respectively. These canals are easier to protect, though, as they both fall within the contiguous borders of their respective countries (see figures 8 & 9).[40] A visit by the author to the Suez Canal, for instance, confirms its diligent protection by the Egyptian 2d Field Army.

[39] "Strait of Malacca," Encarta Online Atlas, <http://encarta.msn.com/map>, accessed 5 April 2005.
[40] "Panama Canal" and "Suez Canal," Encarta Online Atlas, <http://encarta.msn.com/map>, accessed 5 April 2005.

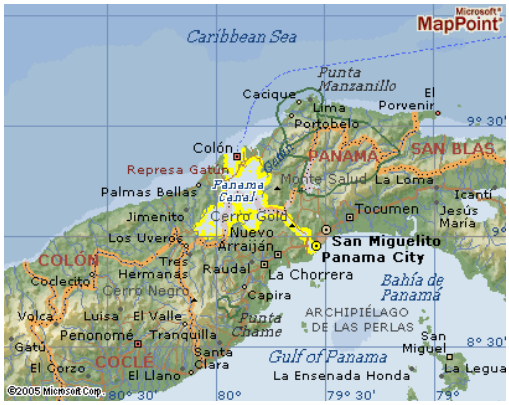

Figure 8: Panama Canal

Figure 9: Suez Canal

A more detailed list of these critical maritime chokepoints is included in Appendix A.

Cyber Vulnerabilities

The widespread expansion of computer-based automation and management systems within the global oil industry over the last 25 years has vastly increased the efficiency of the business. It has also created a critical vulnerability that does not fall within the traditional physical security realm. Today, the exposure to computer-based attacks is a reality, and the consequences are potentially worse than when the only concern was protecting the physical infrastructure.

The modern oil infrastructure, which has always been global in nature, has developed into a complex, interconnected, interdependent system supported in large part by information

technology and telecommunications systems. Specifically, almost every critical element of the oil infrastructure is supported by supervisory control and data acquisition (SCADA) systems. The traditional doctrine of "guns, gates, and guards" does very little to prevent internet-based cyber-terror conducted by "hackers, disgruntled workers, cyber terrorists, cyber activists, cyber militia, rogue nation states, and others who exploit cyber vulnerabilities."[41] As with most commercial information technology (IT) hardware and software, the rush to market the newest technology in many cases outpaces the security precautions to protect against hackers, viruses, etc. Also, because SCADA systems are inherently interdependent with worldwide telecommunications systems, a successful attack on their critical nodes (kinetic or cyber) would affect oil supply operations. As Anthony Cordesman summarizes:

> Today's global communications networks, which are crucial to operating businesses, rely on the Internet, Intranets, and Extranets tied to laptops, desktops, servers, firewalls, and routers. They depend on an open telecommunications architecture of satellites, fiber cables, microwave, phones, pagers, and cellular equipment. Consequently, a disruption to any of this equipment can threaten the reliability of the infrastructures.[42]

[41] Anthony H. Cordesman, "Energy Developments in the Middle East" draft report for the Center for Strategic and International Studies, Washington, D.C., 15 March 2004, 20.
[42] Anthony H. Cordesman, "Energy Developments in the Middle East" draft report for the Center for Strategic and International Studies, Washington, D.C., 15 March 2004, 23.

Part IV: ECONOMIC CONSEQUENCES

The health of the U.S. economy is in large part dependent on the health of the global economy. Oil is a global commodity, and the U.S. must compete with the global market for its supply. Because of this, it is the sum total of the global supply of oil, not where the U.S. imports from in particular, that establishes the availability (and therefore the price) for the entire world. In other words, even if the U.S. found another foreign (or domestic) source of oil to replace its imported supply from the Middle East in an attempt to “protect” itself from the volatility of the MENA region, it would still pay the higher price of a MENA-induced oil shock because it is a global market place.

Historically, it has been Saudi Arabia’s spare capacity that has prevented oil shocks if the supply is temporarily interrupted somewhere. Currently, however, terrorists in Iraq are testing this. "As long as Iraq is out, more of Saudi Arabia's spare capacity is being used up. And it's Saudi Arabia's spare capacity that prevents shocks if something goes wrong somewhere," said Adam Sieminski, Deutsche Bank global oil strategist in London. "So until Iraq comes back in and eases the situation for the Saudis, we're subject to more upside shock

potential... "[43] This drives home the point that, in order for U.S. oil supplies to be secure, it must ensure the security of the foreign oil infrastructure which it relies on.

Historical

The first oil shock occurred in October 1973, when the Arab Oil Embargo was orchestrated by Saudi Arabia, who was angry at the U.S. for its support of Israel during the Yom Kippur War. OPEC cut production and curtailed exports to the U.S. and its key allies, quadrupling oil prices. This plunged the U.S. into a recession, complete with the loss of 500,000 jobs, and a GNP decline of 6%.[44] A second oil shock occurred in 1979, after the Shah of Iran was overthrown. Iran shut down exports for months, and the other members of OPEC, specifically Saudi Arabia and its spare capacity, could not make up the difference, causing oil prices to double. [45]

Current

Analysts say the risk of a supply interruption is reflected in prices, which have remained at the high end of OPEC's target

[43] Warren Vieth, "Supplier Vulnerability Poses a Threat to U.S. Oil Security," Los Angeles Times, 14 September 2003, sec. C.
[44]Anne Korin and Gal Luft, "Terror's Next Target?," *Journal of International Security Affairs*, Winter 2004, 100.
[45] Warren Vieth, "Supplier Vulnerability Poses a Threat to U.S. Oil Security," *Los Angeles Times*, 14 September 2003, sec. C.

range for the latter half of 2004.[46] The rise in prices is not fully explained by the interruptions in the Iraqi supply, and is commonly referred to as the "terror premium." Terrorists are well aware of the economic consequences of their actions, evident in the aforementioned December 2004 Bin Laden tape. Several recent attacks on both the oil infrastructure and foreigners in Saudi Arabia have caused a negative reaction in the oil markets. As the world's largest oil exporter, "instability in the kingdom would wreak havoc with energy supplies and the economy around the globe." [47]

Former CIA Middle East field officer Robert Baer sums it up well:

> A terrorist attack on either one of these hubs of the Saudi oil complex or a simultaneous attack on a few of them is not a fictional scenario. A single terrorist cell hijacking an airplane in Kuwait or Dubai and crashing it into Abqaiq or Ras Tanura, could turn the complex into an inferno. This could take up to 50% of Saudi oil off the market for at least six months and with it most of the world's spare capacity, sending oil prices thought the ceiling. Such and attack would be more economically damaging than a dirty nuclear bomb set off in midtown Manhattan or across from the White House in Lafayette Square.[48]

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[46] Warren Vieth, "Supplier Vulnerability Poses a Threat to U.S. Oil Security," Los Angeles Times, 14 September 2003, sec. C.
[47] Richard A. Greene, "Is the Saudi Oil Industry Safe?," *BBC News Online*, 3 June 2004, <http://news.bbc.co.uk/1/hi/world/middle_east/3771097.stm>, accessed 5 April 2005.
[48] Anne Korin and Gal Luft, "Terror's Next Target?," *Journal of International Security Affairs*, Winter 2004, 96.

Bin Laden has already said he intended to hit the West's oil supply in December 2004, and this threat alone drove oil prices up five percent the next trading day.[49] This demonstrates that the psychological effects of an attack could be far greater than any physical destruction.

[49] Mordechai Abir, "The Al-Qaeda Threat to Saudi Arabia's Oil Sector," brief for the *Jerusalem Center for Public Affairs*, vol. 4, no. 13, 28 December 2004, <http://jcpa.org/brief/brief004-13.htm>, accessed 5 April 2005.

Part V: THREAT MITIGATION / CONCLUSION

Domestic

Since 9-11, the U.S. oil industry has been actively engaged in reassessing potential threats and its vulnerability to terrorism. The industry, with the American Petroleum Institute (API) as its representative, has been working closely with both the Department of Energy and the Department of Homeland Security to ensure that the nation's oil supply is safe and secure. In a report dated April 2003, API outlined the enhanced security measures that have been implemented by the U.S. oil industry at facilities across the country. These measures include the establishment of government-industry partnerships, the benchmarking and sharing of security "best practices" within the industry, and the development of industry security guidelines. Individually, companies have improved their physical and cyber security, access control procedures, and now conduct regular vulnerability assessments. A more extensive list of these measures can be found in Appendix B.

Most companies are absorbing the costs of the increased security measures, but extensive security costs do not improve profit margins and therefore are not very popular in private industry. The development of advanced measures will

depend on finding other ways to pay the bill. The government will have to play a role in this. Addressing this security issue before Congress, Federal Reserve Board Chairman Alan Greenspan recently warned lawmakers that "the nation's energy infrastructure still must be updated to meet long-term demand."[50]

Perhaps even more important than upgrading physical security measures is the increased emphasis on a more systemized approach and a continuing re-evaluation of corporate contingency plans in consultation with the federal government.[51] API has been working closely with the government to "enhance information sharing and to learn how to better cooperate with authorities with access to higher levels of intelligence, warnings, and protection systems."[52] Both the oil industry and the federal government have leveraged the cooperation experiences from the "Y2K" drill which occurred previously. Working with private firms and the U.S. Departments of Energy and Homeland Security, the industry has developed an Information Sharing and Analysis Center, which provides companies a repository of information on "threats, vulnerabilities, early notification of physical and cybernetic threats…and provides a forum for members to

[50] Maureen Lorenzetti, "U.S. Energy Infrastructure now a Key Issue in Washington," *Oil & Gas Journal*, 1 October 2001, 22.
[51] Kathleen McFall, "Post-9/11 Investigations Reveal Oil, Gas Achilles Heel Multiple vulnerabilities are in sprawling U.S. energy chain," *Engineering News Record*, 10 March 2003, 11.
[52] Paula Dittrick, "U.S. Oil, Gas Companies Reassessing Post-Sept 11 Security Risks," Oil & Gas Journal, 22 April 2002, 24.

communicate."[53] This will serve to expedite the information flow for the industry.

Foreign

Internationally, many of the same security responses have also taken place, to varying degrees. Senior officials at Saudi Arabia's Aramco have stated that as much as forty percent of its employees were involved in the security of facilities.[54] Major capital investments are also planned in the arena of mitigating the threats to sea-going transportation. For example, China is developing plans to build a massive canal through Thailand's Kra Isthmus in order to bypass the Straits of Malacca.[55] Also in the process is a pipeline "from the Israeli port of Ashkelon on the Mediterranean coast through which Russian oil from the Black Sea would flow to Eilat on the Red Sea, be loaded onto tankers and shipped to Asia" providing a much shorter link between the Mediterranean and Asia, and "sparing Asian nations the need to transport oil through the dangerous waters of the Persian Gulf."[56] This would avoid the high-seas shipping threats, and also add some redundancy to the oil flow.

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[53] Paula Dittrick, "U.S. Oil, Gas Companies Reassessing Post-Sept 11 Security Risks," Oil & Gas Journal, 22 April 2002, 24.
[54] Norman L. Cigar, <quanti548@hotmail.com> "Aramco," 24 April 2005, personal e-mail (24 April 2005).
[55] Anne Korin and Gal Luft, "Terror's Next Target?," *Journal of International Security Affairs*, Winter 2004, 100.
[56] Anne Korin and Gal Luft, "Terror's Next Target?," *Journal of International Security Affairs*, Winter 2004, 100.

Conclusion

The United States cannot insulate itself from the global oil market. To do so would mean becoming totally independent of any globally traded sources of energy. Whether that means doubling its current production capability, or relying on alternative energy sources is irrelevant, as neither will happen in the foreseeable future.

The U.S. oil industry and the U.S. government are currently taking all the reasonable steps to make the U.S. domestic infrastructure secure. The chief vulnerability, however, resides in the country's foreign sources of supply and the international oil transportation infrastructure. The mitigation of this vulnerability can be accomplished through several avenues. One way is to encourage and assist other oil-producing nations to effectively secure all aspects of their infrastructure. In some countries, this will only require technical assistance. In others, a capital investment might be required.

Another way falls into the diplomatic realm. Because the oil market is global, the U.S. cannot afford to see other economies collapse due to oil interruptions. In the long term,

security depends on stability and prosperity, which creates a difficult environment for terrorists to operate in.

Of course, a third option is to hunt down and kill the threat. As the events over the last three years have demonstrated, this option offers varying degrees of success. Regardless, any long-term strategy (30-50 years) should focus on alternative and renewable energy sources which would minimize U.S. reliance on the international market for its energy. This is a tall order, and will only prove successful if the research and development investment is made now.

APPENDIX A

Following are profiles on the major world oil transit chokepoints provided by the U.S. Department of Energy's Energy Information Agency:[57]

Bab el-Mandab
Location: Djibouti/Eritrea/Yemen; connects the Red Sea with the Gulf of Aden and the Arabian Sea
Oil Flows (2000E): 3.2-3.3 million bbl/d
Destination of Oil Exports: Europe, United States, Asia
Concerns/Background: Closure of the Bab el-Mandab could keep tankers from the Persian Gulf from reaching the Suez Canal/Sumed Pipeline complex, diverting them around the southern tip of Africa (the Cape of Good Hope). This would add greatly to transit time and cost, and effectively tie up spare tanker capacity. In December 1995, Yemen fought a brief battle with Eritrea over Greater Hanish Island, located just north of the Bab el-Mandab. The Bab el-Mandab could be bypassed (for northbound oil traffic by utilizing the East-West oil pipeline, which traverses Saudi Arabia and has a capacity of about 4.8 million bbl/d. However, southbound oil traffic would still be blocked. In addition, closure of the Bab el-Mandab would effectively block non-oil shipping from using the Suez Canal, except for limited trade within the Red Sea region.

Strait of Hormuz
Location: Oman/Iran; connects the Persian Gulf with the Gulf of Oman and the Arabian Sea
Oil Flows (2002E): 13 million bbl/d
Destination of Oil Exports: Japan, United States, Western Europe
Concerns/Background: By far the world's most important oil chokepoint, the Strait consists of 2-mile wide channels for inbound and outbound tanker traffic, as well as a 2-mile wide buffer zone. Closure of the Strait of Hormuz would require use of longer alternate routes (if available) at increased transportation costs. Such routes include the 5 million-bbl/d capacity Petroline (East-West Pipeline) and the 290,000-bbl/d Abqaiq-Yanbu natural gas liquids line across Saudi Arabia to the Red Sea. Theoretically, the 1.65-million bbl/d Iraqi Pipeline across Saudi Arabia (IPSA) also could be utilized, more oil could be pumped north to Ceyhan (Turkey), and the 0.5 million-bbl/d Tapline to Lebanon could be reactivated.

[57] "World Oil Transit Chokepoints," *Energy Information Agency, U.S. Department of Energy* web site, <www.eia.doe.gov/emeu/security/choke.html>.

Strait of Malacca

Location: Malaysia/Singapore; connects the Indian Ocean with the South China Sea and the Pacific Ocean.

Oil Flows (2002E): 10.3 million bbl/d

Destination of Oil Exports: Japan, South Korea, China, other Pacific Rim countries.

Concerns/Background: The Strait of Malacca, linking the Indian and Pacific Oceans, is the shortest sea route between three of the world's most populous countries -- India, China, and Indonesia -- and therefore is considered to be the key choke point in Asia. The narrowest point of this shipping lane is the Phillips Channel in the Singapore Strait, which is only 1.5 miles wide at its narrowest point. This creates a natural bottleneck, with the potential for a collision, grounding, or oil spill (in addition, piracy is a regular occurrence in the Singapore Strait). If the strait were closed, nearly half of the world's fleet would be required to sail further, generating a substantial increase in the requirement for vessel capacity. All excess capacity of the world fleet might be absorbed, with the effect strongest for crude oil shipments and dry bulk such as coal. Closure of the Strait of Malacca would immediately raise freight rates worldwide. More than 50,000 vessels per year transit the Strait of Malacca. With Chinese oil imports from the Middle East increasing steadily, the Strait of Malacca is likely to grow in strategic importance in coming years.

Suez Canal and Sumed Pipeline

Location: Egypt; connects the Red Sea and Gulf of Suez with the Mediterranean Sea

Oil Flows (2001E/2002E): 3.8 million bbl/d. Of this total, the Sumed Pipeline transported 2.5 million bbl/d of oil northbound (nearly all from Saudi Arabia) and the Suez Canal around 1.3 million bbl/d total.

Destination of Sumed Oil Exports: Predominantly Europe; also United States.

Concerns/Background: Closure of the Suez Canal and/or Sumed Pipeline would divert tankers around the southern tip of Africa (the Cape of Good Hope), adding greatly to transit time and effectively tying up tanker capacity.

Bosporus/Turkish Straits

Location: Turkey; this 17-mile long waterway divides Asia from Europe and connects the Black Sea with the Mediterranean Sea

Oil Flows (2001E): 2.0 million bbl/d (nearly all southbound; mostly crude oil with several hundred thousand barrels per day of products as well)

Destination of Oil Exports: Western and Southern Europe;
Concerns/Background: Only half a mile wide at its narrowest point, the Turkish Straits are one of the world's busiest (50,000 vessels annually, including 5,500 oil tankers), and most difficult-to-navigate waterways.

Panama Canal and Trans-Panama Pipeline
Location: Panama; connects the Pacific Ocean with the Caribbean Sea and Atlantic Ocean
Oil Flows (2001E): 613,000 bbl/d
Concerns/Background: The Panama Canal extends approximately 50 miles from Panama City on the Pacific Ocean to Colon on the Caribbean Sea. In fiscal year (FY) 2001, petroleum and petroleum products was the largest commodity (by tonnage) shipped through the Canal, accounting for 16% of total canal shipments. Around 64% of total oil shipments went south from the Atlantic to the Pacific, with oil products dominating southbound traffic. Chemicals (including petrochemicals) and coal are shipped through the canal as well, accounting for 5% and 3%, respectively, of total Canal traffic. The largest vessel that can transit the Panama Canal is known as a PANAMAX-size vessel. A long-term program is underway to widen the narrow, eight-mile stretch of Gaillard Cut to allow unrestricted two-way traffic of PANAMAX-size vessels.

Russian Oil and Gas Export Pipelines/Ports
Location: Russian oil and gas exports transit via pipelines that pass through Russia, Ukraine, Belarus, Hungary, Slovakia, the Czech Republic, and Poland,
Major Oil Export Ports: Novorossiisk (Russia -- Black Sea); Primorsk (Russia -- Baltic Sea/Gulf of Finland); Tuapse (Russia); Ventspils (Latvia); Odessa (Ukraine)
Major Oil Pipelines (capacity, 2002E): Druzhba (1.2 million bbl/d); Baltic Pipeline System (240,000 bbl/d); CPC Tengiz-Novorossiisk Pipeline (564,000 bbl/d, most of which is Kazakh crude)
Major Natural Gas Pipelines (capacity, 2002E): Brotherhood, Progress, and Union (1 trillion cubic feet -- tcf -- capacity each); Northern Lights (0.8 tcf); Volga/Urals-Vyborg, Finland (0.1 tcf). Yamal (to Europe, via Belarus; 1.0 Tcf, partly operational); Blue Stream (to Turkey via Black Sea; 0.56 Tcf, construction completed in October 2002)
Destination of Oil and Gas Exports: Eastern Europe, Netherlands, Italy, Germany, France, other Western Europe.
Concerns/Background: Russia is a major supplier of crude oil and natural gas to Europe. All of the ports and pipelines are operating at or near capacity, leaving limited alternatives if

problems arose at Russian export terminals. In addition, many of the country's oil pipelines are in a state of disrepair, and Russian Energy Ministry figures indicate that almost 5% of crude oil produced in Russia is lost through illegal tapping of Russia's pipelines. With a windfall in oil export tariffs over the past several years, Transneft, the state oil transport monopoly, has taken steps to upgrade the country's pipeline system, with an emphasis on building new export pipelines to increase and diversify export routes for oil exporters.

APPENDIX B

In a report dated April 2003, API outlined the enhanced security measures that have been implemented by the U.S. oil industry at facilities across the country:[58]

- API established a DOE/Industry Security Partnership, including vulnerability assessment, threat information sharing and technology transfer
- API is conducting industry security conferences and workshops, emphasizing best practice sharing and benchmarking
- Industry has set up an Energy Industry Information Sharing and Analysis Center (ISAC) to help better share intelligence and industry practices
- API has developed Industry Security Guidelines and a Petroleum Industry Security Vulnerability Assessment Methodology
- Individual companies have improved security measures by:
    - Conducting security vulnerability assessments
    - Establishing access control procedures for persons and vehicles entering and leaving the facility
    - Establishing heightened security procedures for handling packages
    - Enhancing perimeter protection against vehicular intrusion
    - Bolstering security procedures for ship personnel disembarking the ship onto facility docks
    - Applying technical security sensors and intrusion detection to facility perimeters and waterside access
    - Liaison and coordination with industry leaders to exchange security best practices and countermeasures
    - Establishing or enhancing corporate in-house intelligence gathering and analysis capabilities

[58] American Petroleum Institute, “Security Guidelines for the Petroleum Industry,” April 2003, 3.

- Increasing security guards and surveillance equipment
- Conducting background checks of employees and contractors
- Tracking security information and alert levels and have appropriate security procedures in place to respond to the alert levels.
- Modifying assessments relating to physical security, product theft and hostile threat
- Providing 24/7 lock-in with card-in procedures at marketing terminals
- Instructing drivers not to leave running trucks or keys unattended (trucks are kept locked while driving and unloading)
- Enhancing communications with local police and emergency response personnel to discuss emergency procedures and security issues
- Locking pumps at loading facilities to prevent theft
- Assessing the need for 24/7 attendants at retail facilities
- Considering biomarker identification technology for marketing terminal access
- Requiring heightened awareness by facility personnel for suspicious behavior
- Use of video/CCTV to monitor remote areas such as docks and gates.

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